6. CONCLUSIONS

Spaulding hypothesized that man-made noise values, as reported in CCIR Report 258, may no longer be valid because of changes in electrical device technology such as the quieting of automotive ignition systems. These changes necessitate the measurement and modeling of man-made noise to determine if this is indeed the case. In this report the 136 to 138-MHz meteorological satellite band was measured and modelled, since space-to-earth links in this band are impacted greatly by man-made noise. We found that the characteristics of man-made noise in this band have changed, and we recommend further noise measurements in this band and others. The most striking results were the lack of within-the-hour variability of F_a in all environments, the drop in F_{am} for residential environments, and the relative quietness of the automobiles.

Graphs depicting the time-varying median, mean, and peak noise powers were presented in Section 3. The graphs show that within-the-hour variation of F_a is relatively small. CCIR Report 258 provided upper and lower decile values, D_u and D_l respectively, for within-the-hour variation of F_a as a function of frequency and environment. Spaulding and Stewart [14] have analyzed the data used to obtain D_u and D_l and have found it appropriate to use D_u = 9.7 dB and D_l = 7 dB, independent of environment or frequency. These decile values correspond to a within-the-hour standard deviation of approximately 6.6 dB. Clearly our measurements and those used for CCIR Report 258 differ significantly in within-the-hour variability.

The measured F_{am}, presented in Section 4, was 18.0, 6.0, and 6.3 dB for business, residential, and rural environments. CCIR Report 258 gives 17.6, 13.3, and 8.0 dB for the same environments [2]. Only residential F_{am} has changed appreciably from those values reported by the CCIR. These findings are significant for radio link designers. The discussion in Section 4 indicates that the CCIR noise measurement data were collected and analyzed somewhat differently. In particular, (1) the CCIR noise measurement data were collected during “mobile runs” through a “measurement area” while the measurements in this report were collected while stationary, (2) CCIR measurement data contained more location variability but not as much hour-to-hour time variability as the measurements in this report, and (3) CCIR estimates of F_{am} were dependent upon its behavior over 8 frequencies, whereas the estimate in this report is derived from measurements in a single frequency. Further measurements and analysis are needed to determine if these changes in measurement and analysis methods have impacted our conclusions.

Measurements of automobile noise suggest that automobiles are no longer a significant VHF noise source. In fact, stretches of urban highway were found to be quiet enough to coin the "light urban" environment classification. For example, Figure 3.6 shows automobile noise along an isolated mountain canyon road with an F_a of approximately 4 dB and Figure 3.3a shows automobile noise along an interstate highway adjacent to an office park with an F_a of approximately 7 dB. Spaulding's measurements [1] predict an F_a of approximately 15 dB for locations adjacent to interstate highways.

Power-line noise was noticed throughout the measurement campaign. Our limited measurements of power transmission- and distribution-lines indicate that this problem still exists. The power-line measurements were conducted in a rural setting on a road perpendicular to a high-voltage transmission line and parallel to a lower voltage distribution line. Measurements near the high-voltage transmission line did not show an unusually high F_a at 136-138 MHz. Along the road, farther from the high-voltage transmission line, yet still near the lower voltage distribution line, the noise was found to be highly variable. This variability due to power lines is likely to be experienced in business, residential, and rural areas.

Computers were found to be capable of generating a significant amount of noise in this band. A simple experiment was conducted in a rural setting which documented the noise from two randomly selected computers. One of the computers was found to be noisy while the other was relatively quiet. Measurements outside our laboratory indicated that a telecommunication “switch” with an embedded computer introduced a narrowband continuous tone in the measurement receiver passband. Further study is needed to determine how narrowband noise power from computers and other electronic devices within a building would impact a receiving antenna mounted on or near an office building.

Analysis of noise APD’s revealed a wide spectrum of noise types. Nakagami-Rice interference was found in several bussiness locations. This interference has a constant component along with a Gaussian component. Class A pulsed interference (emission bandwidth less than measurement bandwidth) was measured infrequently in all environments. Generally several hours passed between Class A interference events. We speculate that Class A noise events may be the result of line spectra generated from electrical devices.

Class B pulsed interference (emission bandwidth greater than measurement bandwidth) is by far the most common. Middleton spent considerable effort in modelling this class of noise. Using the ideas put forward by Middleton, we constructed a simplified noise model dependent upon a small set of parameters that were derived from the measurements. Using this approach we were able to simulate noise with first-order statistics that agreed with our measurements.